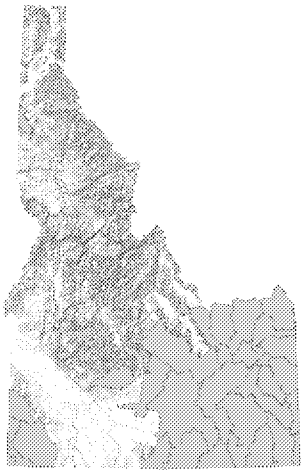
Justification for Site-Specific Selenium Criterion for Aquatic Life in Portions of Idaho



State of Idaho
Department of Environmental Quality
Water Quality Division
1410 N. Hilton
Boise, Idaho 83706

November 2017

Printed on recycled paper, DEQ August 2017, PID WQST0503, CA 82136. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Section 60-202, Idaho Code.

Table of Contents

List of Tables

List of Figures

List of Acronyms

BAF	bioaccumulation factor
CF	conversion factor
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
GMCV	genus mean chronic value
HUC	hydrologic unit code
IDFG	Idaho Department of Fish and Game
µg/L	micrograms per liter
mg/g	milligrams per gram
L/g	liter per gram
mg/kg dw	milligrams per kilogram dry weight
Se	selenium
SSC	site-specific selenium criterion

1 Introduction

This document provides the scientific justification and rationale for including a site-specific selenium criterion (SSC) in Idaho Code (Subsection 287.05) for waters within the geographic scope identified in section 2.4 of this document. The proposed SSC and related justification was informed by various stakeholders participating in the negotiated rulemaking process used by the Idaho Department of Environmental Quality (DEQ) to update its statewide selenium (Se) criterion for aquatic life (DEQ Docket No. 58-0102-1701).

This SSC was derived according to the procedures set forth in IDAPA 58.01.02.275.01.h. These procedures allow site-specific aquatic life criteria to be derived using scientifically justifiable approaches consistent with the assumptions and rationale in United States Environmental Protection Agency (EPA) guidance. Specifically, we derived fish tissue criterion elements using current EPA guidance on site-specific species deletion (EPA 2013) and criterion recalculation (EPA 1985) to account for differences in Se sensitivity between resident species within the Site and those species used in deriving the proposed statewide criterion.

Although Se may cause acute toxicity at high concentrations, the most detrimental effect on aquatic organisms is due to its bioaccumulative properties. Aquatic organisms exposed to Se accumulate it primarily through their diets and not directly from the water. In fish, Se toxicity occurs primarily through transfer to the eggs, reducing reproductive success and survival. In aquatic communities, fish are the most sensitive to Se effects (EPA 2016). Aquatic communities are expected to be protected from any potential acute effects of Se by this chronic criterion (EPA 2016).

Consistent with DEQ's proposed statewide Se criterion and the EPA's recommended national Se criterion (EPA 2016), the proposed SSC consists of four elements. They include a (1) fish egg-ovary element; (2) fish whole-body and/or muscle element; (3) water column element, which includes one value for lentic (still water) and one value for lotic (running water) aquatic systems; and (4) water column intermittent element to account for potential chronic effects from short-term exposures, which also includes one value for lentic and one value for lotic aquatic systems.

The proposed SSC elements are derived from the allowable concentration of Se in fish egg-ovary tissue of species or species surrogates that reside within the Site described below in section 2. Like DEQ's proposed statewide criterion and EPA's recommended national criterion, the SSC elements are protective of the Site's entire aquatic community, including fish, amphibians, and invertebrates. Criterion elements for whole-body and muscle tissue are based on ratios of concentrations in egg-ovary to concentrations in other tissues. These fish tissue concentrations, in conjunction with bioaccumulation factors (BAFs), are used to derive the water column elements, representing allowable concentration of Se in ambient water.

Both EPA's recommended national criterion and DEQ's proposed statewide criterion is based on the four most sensitive taxa in the national toxicity dataset. The species most sensitive to Se in the national toxicity dataset is White Sturgeon (*Acipenser transmontanus*)(EPA 2016). In Idaho, however, White Sturgeon have a limited range and are present only in select mainstem rivers (IDFG 2008). In order to protect the resident species assemblage within the Site and follow

Idaho Code stringency requirements, we provide the following scientific rationale for the proposed SSC.

The core steps for developing the proposed SSC include the following:

- Defining the geographic scope of the SSC (i.e., the Site)
- Determining the resident fish species that occur in the Site
- Recalculating the Se criterion based on resident fish species
- Evaluating of protectiveness of the SSC to resident fish species expected to be present in the Site

2 Geographic Scope of the SSC

To identify the Site, we must first identify waters located outside of White Sturgeon's historical range that do not provide required habitat elements to maintain a self-propagating population. Next we consider where White Sturgeon does not serve as a surrogate for another species. Finally, we provide a buffer by excluding from the Site waters that drain to these waters within the historical range of White Sturgeon. Thus the Site for purposes of this SSC is limited to waterbodies outside of the historical range of White Sturgeon, subbasins that do not drain directly into those waterbodies, and waterbodies not designated as critical habitat for Bull Trout or anadromous salmonids.

2.1 Sturgeon Occurrence and Habitat

In Idaho, White Sturgeon presence and historical range is limited to the mainstems of the Kootenai, Snake, and Salmon Rivers (Figure 1).

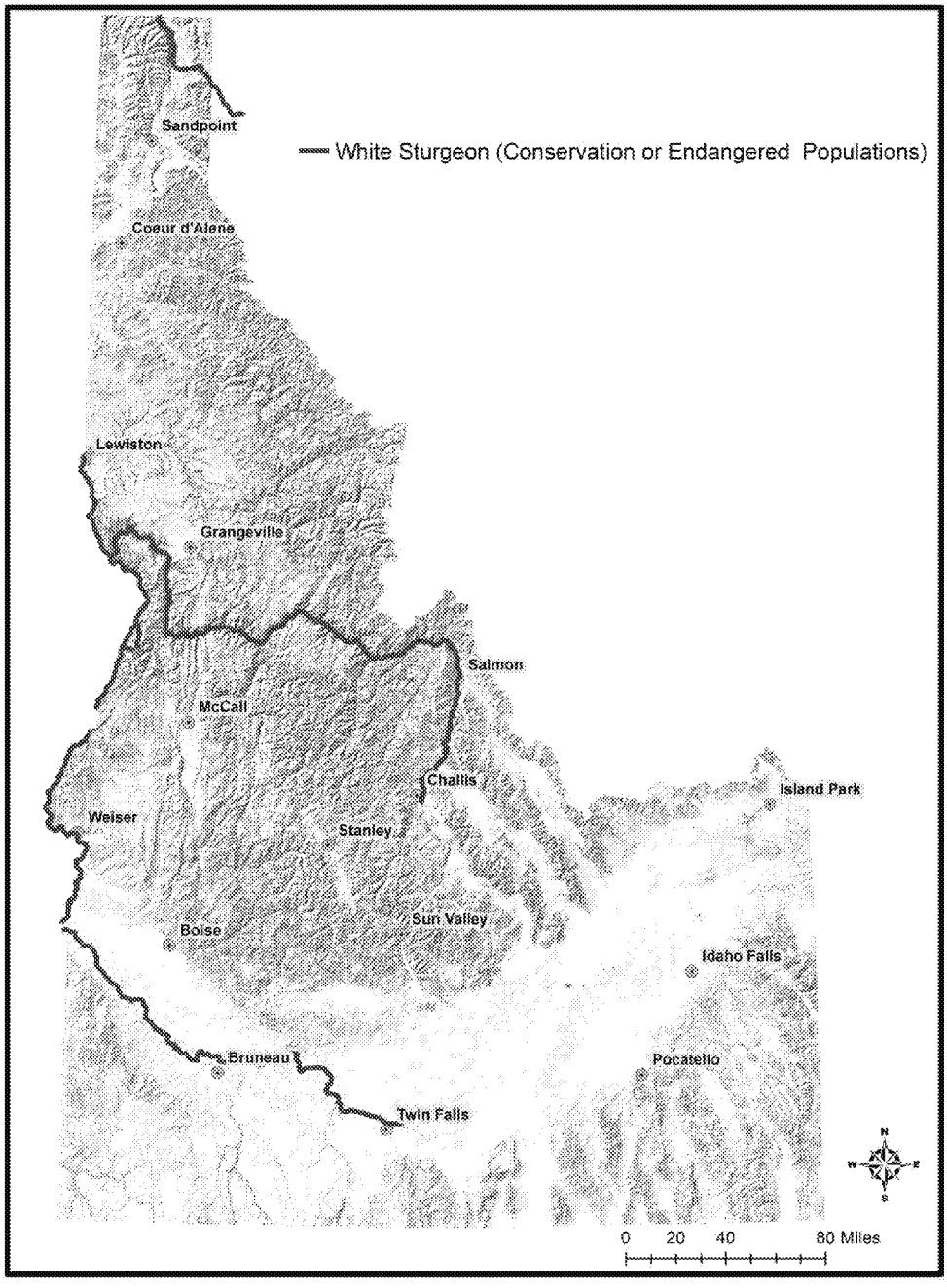


Figure 1. Historical range of White Sturgeon (*Acipenser transmontanus*).

The Kootenai River is habitat for an endangered population of White Sturgeon. The Kootenai River originates in Kootenay National Park in British Columbia, flows south into Montana, northwest into Idaho, then north through the Kootenai Valley back into British Columbia.

The Snake River population in Idaho is found in the Salmon and Snake Rivers. Although there are no barriers on the Salmon River, the White Sturgeon is rarely seen above the North Fork Salmon River (IDFG 2008). In the Snake River, individuals historically ranged upstream to Shoshone Falls. In 1990 they were introduced below American Falls Dam and at Idaho Falls (IDFG 2008). The Idaho Department of Fish and Game (IDFG) continues to stock hatchery-

produced White Sturgeon at American Falls Dam and Idaho Falls and manages them as a non-propagating sport fish population to expand White Sturgeon fishing opportunity outside its historical range (IDFG 2008). Since these fish are not expected to reproduce (IDFG 2008) and Se primarily affects fish populations through reproduction (EPA 2016), DEQ finds it appropriate to include all of the Snake River above Shoshone Falls as part of the Site for this SSC.

2.2 Critical Salmonid Habitat

Critical habitats of Bull Trout and anadromous salmonids are also excluded from the Site to ensure there is no adverse modification of critical habitats (Figure 2). Both Bull Trout and anadromous salmonid populations are protected from impacts of Se under the proposed statewide Se criterion.

2.3 Buffering White Sturgeon Waters

To further protect water quality where White Sturgeon may be present, we also include certain upstream waters where White Sturgeon is not expected to be found but that contribute to downstream water quality. For this SSC, all 4th field hydrologic unit codes (HUCs) flowing directly into the Kootenai and Salmon Rivers as well as Snake River below Shoshone Falls are excluded from the definition of the Site for this SSC.

Figure 2. HUCs identified as White Sturgeon waters or critical salmonid habitat.

2.4 Site Definition

Based on the above considerations, the Site for purposes of this SSC is defined as all waters of the state except: (a) the main stems of the Kootenai, Salmon, and Snake Rivers within the historical range of White Sturgeon, (b) 4th field HUCs flowing directly into the historical range of White Sturgeon, and (c) designated critical salmonid habitat or Bull Trout habitat (Table 1, Figure 3).

Table 1. Subbasins and 4th field HUCs included in the Site.

HUC	Subbasin
16010102	Central Bear
16010201	Bear Lake
16010202	Middle Bear
16010203	Little Bear-Logan
16010204	Lower Bear-Malad
16020309	Curlew Valley
17010302	South Fork Coeur d'Alene
17010306	Hangman
17010308	Little Spokane
17040104	Palisades
17040105	Salt
17040201	Idaho Falls
17040202	Upper Henrys
17040203	Lower Henrys
17040204	Teton
17040205	Willow
17040206	American Falls
17040207	Blackfoot
17040208	Portneuf
17040209	Lake Walcott
17040210	Raft
17040211	Goose
17040214	Beaver-Camas
17040215	Medicine Lodge
17040216	Birch
17040218	Big Lost
17040220	Camas
17040221	Little Wood
17050104	Upper Owyhee
17050105	South Fork Owyhee
17050106	East Little Owyhee
17050107	Middle Owyhee
17050108	Jordan
17060109	Rock

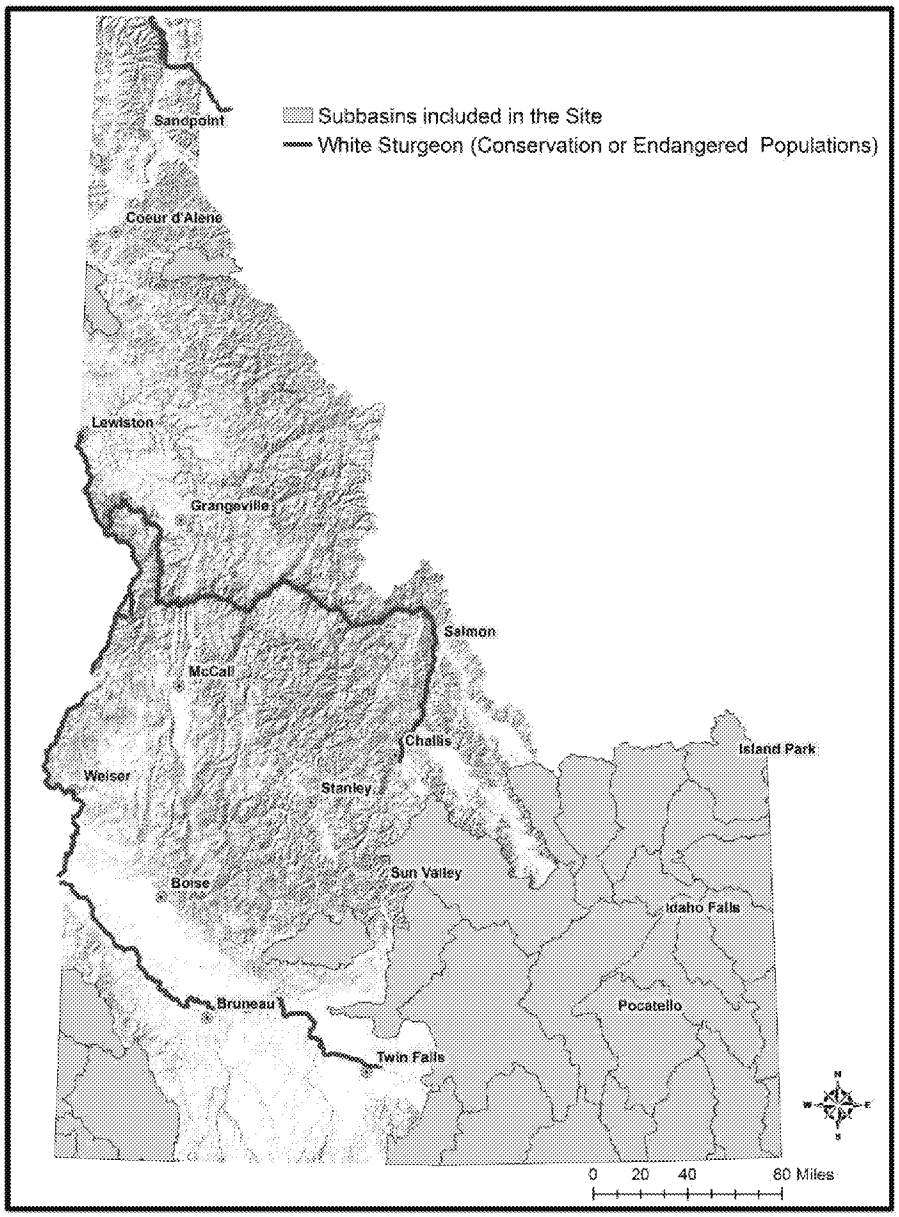


Figure 3. Geographic scope of the SSC.

3 Determination of Resident Fishes Occurring Within the Site

The EPA has developed a recalculation procedure for creating a site-specific toxicity dataset and species sensitivity distribution that is appropriate for deriving a site-specific aquatic life criterion (EPA 2013, 1985). The procedure provides guidance on modifying the national toxicity dataset for Se by correcting, adding, and/or deleting test results for species not relevant to the site in question. Deletion is based on taxonomic composition of the site; tested species most closely related to those occurring at the site are retained as surrogates.

According to the recalculation procedure, a species included in the national toxicity dataset for the pollutant under consideration must be retained in the dataset and used to develop a site-specific criterion if the species occurs within the site. However, if a species in the national toxicity dataset does not occur within the site and does not serve as a surrogate for another species, it may be deleted from the dataset used to calculate the site-specific criterion. Therefore, to use the recalculation procedure, DEQ must determine the resident fish species within the Site and determine whether White Sturgeon serve as a surrogate for any of those species.

The resident fishes found at the Site (Appendix A) were determined from state and federal spatial datasets, scientific literature (Sigler and Zaroban in prep.), biological opinions (FWS 2015, NOAA NMFS 2014), and Federal Register notices regarding critical habitat for threatened and endangered fish species in Idaho.

Although hatchery-stock White Sturgeon have been introduced by IDFG outside of White Sturgeon's historical range at two locations within the Site (section 2.1), we find it appropriate to delete White Sturgeon from the national toxicity dataset used to calculate this SSC. This is for two reasons. First, IDFG stocks White Sturgeon in portions of the Site solely to expand sport fishing opportunity. These individuals are not expected to reproduce, nor do these locations provide required habitat elements to maintain a self-propagating population of White Sturgeon, such as adequate water temperature, water flow, or extended reach length between dams (IDFG 2005, 2008). Therefore, we do not consider the White Sturgeon populations outside of their historical range to be resident fish for purposes of the recalculation procedure.

Second, we used the EPA recommended species deletion process (EPA 2013) to identify whether White Sturgeon is a surrogate for any other species occurring in the Site. White Sturgeon is not a surrogate for other resident species because no other species in the same genus, family, or order occurs at the site. Multiple species in the same class as White Sturgeon (*Actinopterygii*) do occur at the Site; however, they, or their surrogate, are in the national toxicity dataset (Appendix A). Using the process described in (EPA 2013), White Sturgeon can be deleted from a site-specific recalculation for aquatic life criteria (Appendix A).

4 Recalculation of the Se Criterion Based on Resident Fishes

This proposed fish tissue SSC (Table 2) is designed to protect resident fishes and other aquatic organisms within the Site since fish are the most sensitive aquatic organisms to Se (EPA 2016). The approach was developed after considering the fishes that occur at the Site, the fish-centric nature of the EPA 2016 Se criterion, and available regulatory guidance concerning scientifically defensible procedures for developing this SSC.

This SSC includes only fish tissue criterion elements. This SSC does not include site-specific water column criterion elements because we do not have the necessary site-specific bioaccumulation information to calculate them using the empirical bioaccumulation factor (BAF) approach described in EPA's national recommended Se criterion (EPA 2016). The data are too few and variable to adequately describe the mean lotic BAF within the Site (Appendix B). Further, we do not have empirical selenium data for lentic systems and, as a result, have no way

to derive a lentic water column value using data from the site. Therefore, the water column criterion elements set out in the statewide rule (footnote *r* in IDAPA 58.01.02.210.01) are also applicable to the water bodies identified in this SSC (Table 1).

Table 2. Site-specific selenium criterion.

Egg-Ovary (mg/kg dw)	Fish Tissue (mg/kg dw)	
Egg-Ovary	Whole Body	Muscle
19.0[a]	9.5[b]	13.1[b]

Notes: mg/kg dw = milligrams per kilogram dry weight; µg/L = micrograms per liter
[a] Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured (single measurement of an average or composite sample of at least five individuals of the same species).
[b] Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured (single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length [size] of the largest individual).

4.1 Derivation of Fish Tissue Values

The national toxicity dataset used to derive DEQ's proposed statewide Se criterion (and EPA's 2016 recommended Se criterion) consists of 15 genus mean chronic values (GMCVs). These include ten fish genera (*Acipenser*, *Salmo*, *Lepomis*, *Micropterus*, *Oncorhynchus*, *Pimephales*, *Gambusia*, *Esox*, *Cyprinodon*, and *Salvelinus*), three invertebrate genera (*Centroptilum*, *Brachionus*, and *Lumbriculus*), and two waived crustacean genera. The crustacean genera were waived because acceptable quantitative chronic toxicity values for Se are not available for crustaceans (EPA 2016). However, information available during EPA's derivation process demonstrated that fish species were more sensitive than crustaceans and were acceptable surrogates (EPA 2016).

After deleting the *Acipenser* Genus Mean Chronic Value (GMCV) from the toxicity dataset, we recalculated Se criterion elements based on the remaining resident species or species surrogates found in the national toxicity dataset as described in section 3. We arranged the 14 remaining GMCVs hierarchically by genera based on Se sensitivity. Using this approach, the four most sensitive genera used to calculate the egg-ovary criterion element of 19.0 milligrams per kilogram dry weight (mg/kg dw) are provided in Table 3. Given that there are species-specific conversion factors (CF) for Se bioaccumulation in different tissue types (i.e., egg-ovary, whole-body, muscle), this hierarchy changes depending on the tissue type being analyzed (EPA 2016).

Table 3. Calculation of the site-specific egg-ovary criterion element for selenium.

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GMCV)^2	P=R/(N+1)[b]	sqrt(P)
Micropterus	4	26.3	3.27	10.69	0.27	0.52
Oncorhynchus	3	25.3	3.23	10.44	0.20	0.45
Salmo	2	21	3.04	9.27	0.13	0.37
Lepomis	1	20.6	3.03	9.15	0.07	0.26
		sum	12.57	39.55	0.67	1.59
					N[c]	14
					S^2[d]	1.28
					S	1.13
					L[e]	2.69
					A[f]	2.95
					FCV[g]	**19.0**

Notes:
[a] Se concentration in mg/kg dw
[b] Cumulative probability
[c] Total number of GMCVs in dataset
[d] $S^2 = \frac{\Sigma((\ln GMCV)^2) - ((\sum lnGMAV))^2/4}{\Sigma(F) - ((\Sigma(\sqrt{P}))^2/4)}$
[e] $L = (\Sigma(\mathrm{lnGMAV}) - S\left(\Sigma\left(\sqrt{P}\right)\right))/4$
[f] $A = S\left(\sqrt{0.05}\right) + L$
[g] Final chronic value (FCV) in mg/kg dw, $FCV = e^A$

The four most sensitive genera used to calculate the whole-body criterion element of 9.5 mg/kg dw are provided in Table 4.

Table 4. Calculation of the site-specific whole-body criterion element for selenium.

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GMCV)^2	P=R/(N+1)[b]	sqrt(P)
Esox	4	14.2	2.65	7.04	0.27	0.52
Salmo	3	13.2	2.58	6.66	0.20	0.45
Oncorhynchus	2	11.6	2.45	6.01	0.13	0.37
Lepomis	1	9.9	2.29	5.26	0.07	0.26
		sum	9.98	24.96	0.67	1.59
					N[c]	14
					S^2[d]	2.03
					S	1.42
					L[e]	1.93
					A[f]	2.25
					FCV[g]	**9.5**

Notes:
[a] Se concentration in mg/kg dw
[b] Cumulative probability
[c] Total number of GMCVs in dataset
[d] $S^2 = \frac{\Sigma((\ln GMCV)^2)-((\sum lnGMAV))^2/4}{\Sigma(F)-((\Sigma(\sqrt{P}))^2/4)}$
[e] $L = (\Sigma(\text{lnGMAV}) - S\left(\Sigma\left(\sqrt{P}\right)\right))/4$
[f] $A = S(\sqrt{0.05}) + L$
[g] Final chronic value (FCV) in mg/kg dw, $FCV = e^A$

The four most sensitive genera used to calculate the muscle criterion element of 13.1 mg/kg dw are provided in Table 5.

Table 5. Calculation of the site-specific muscle criterion element for selenium.

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GMCV)^2	P=R/(N+1)[b]	sqrt(P)
Esox	4	21.7	3.08	9.47	0.27	0.52
Salmo	3	18.5	2.92	8.51	0.20	0.45
Lepomis	2	15.9	2.77	7.65	0.13	0.37
Oncorhynchus	1	14.3	2.66	7.08	0.07	0.26
		sum	11.42	32.71	0.67	1.59
					N[c]	14
					S^2[d]	2.68
					S	1.64
					L[e]	2.21
					A[f]	2.57
					FCV[g]	**13.1**

Notes:
[a] Se concentration in mg/kg dw
[b] Cumulative probability
[c] Total number of GMCVs in dataset
[d] $S^2 = \frac{\Sigma((\ln GMCV)^2)-((\sum lnGMAV))^2/4}{\Sigma(F)-((\Sigma(\sqrt{P}))^2/4)}$
[e] $L = (\Sigma(\text{lnGMAV}) - S\left(\Sigma\left(\sqrt{P}\right)\right))/4$
[f] $A = S(\sqrt{0.05}) + L$
[g] Final chronic value (FCV) in mg/kg dw, $FCV = e^A$

5 Protectiveness of the SSC

5.1 Resident Fishes

Some important families of fish are not represented in EPA 2016 Se Criterion, such as the sculpin family (*Cottidae*) and catfish family (*Ictaluridae*). Sculpin, in the genus *Cottus,* are the only resident species in the family *Cottidae* that occur within the Site. However, no adverse effects were observed from dietary Se on hatching success, fry survival, deformities, fry length, or fry weight up to 22 mg Se/kg egg-ovary dw in Slimy Sculpin (*Cottus cognatus*) (Lo et al. 2014). In addition to this study, available field data indicate sculpins are generally less sensitive to Se than other fish species. Local sculpin population data collected in the Upper Blackfoot River watershed and the adjacent Salt River watershed (Formation and HabiTech, Inc 2012) also suggest sculpins are not particularly sensitive to Se and population densities were not statistically related to either surface water that contained Se concentrations less than 39 micrograms per liter (µg/L) or Se concentrations in sculpin tissue less than 25 mg/kg whole-body dw.

Additionally, species in the catfish family (*Ictaluridae*) were introduced in Idaho for recreational fishing opportunity and are managed as a sport fish (IDFG 2012). These are warm water species, and the vast majority of their current distribution is not within the Site (IDFG 2012). Phylogenetically, the catfish family is more closely related to other tested families (e.g., *Centrarchidae*) than it is to the sturgeon family (*Acipenseridae*) (Appendix A). The catfish family is not represented in the EPA's effects assessment due to the absence of valid tests yielding an EC10 or chronic value. Due to this, EPA evaluated the potential vulnerability of the taxonomic group that includes catfish by examining comparative fisheries observations of *Ictaluridae* and *Centrarchidae* sharing the same Se-contaminated waterbody. *Ictaluridae* abundances were unrelated to either the Se-sensitive centrarchid abundances or to the Se concentrations in the food chain (EPA 2016) and considered less sensitive to Se. Therefore, *Ictaluridae* occurring within the Site will also be protected by this SSC given that genera within *Centrarchidae* were used in the calculation of this SSC.

Lastly, DEQ collected data to determine ambient Se concentrations in waterbodies throughout Idaho. A total of 34 major river sites were randomly sampled in 2008 and 52 composite samples of fish (by species) were collected (DEQ 2010). Se concentrations in fish tissue throughout the state are predominately lower than the respective elements of the SSC (Figure 4).

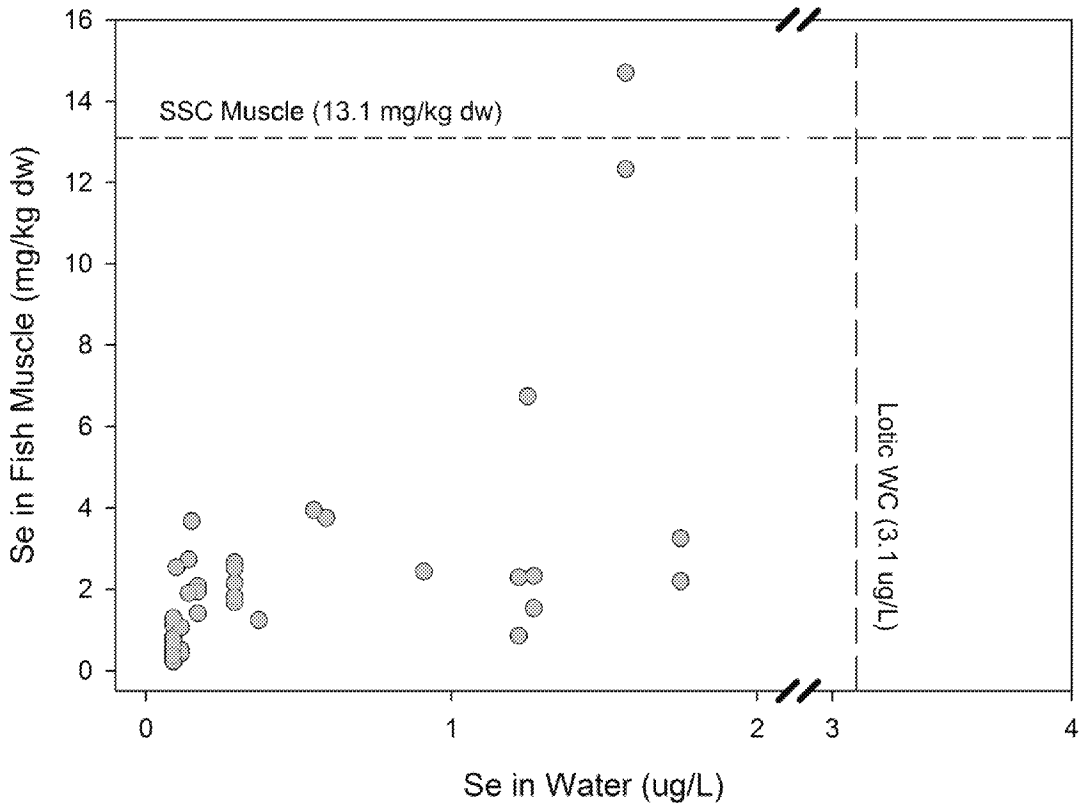


Figure 4. Selenium in water column and fish muscle tissue in Idaho rivers (2008).

Aside from two fish muscle tissue samples collected approximately 10 river miles above the Blackfoot Reservoir in the Blackfoot River (Cutthroat Trout = 14.7 mg/kg dw and Bridgelip Sucker = 12.3 mg/kg dw), all other fish muscle tissue collected were well below the muscle criterion element of 13.1 mg/kg dw proposed in this SSC (DEQ 2010). Se concentrations in the

Blackfoot River are impacted by phosphate mining upstream and this reach of the Blackfoot River is currently impaired for Se (DEQ 2017). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides a framework to address Se pollution and employ remedial actions to reduce Se concentrations in aquatic systems in areas impacted by phosphate mining in southeast Idaho so that they can meet Water Quality Standards. Information on CERCLA investigations and cleanup is available at *http://www.deq.idaho.gov/regional-offices-issues/pocatello/southeast-idaho-phosphate-mining/southeastern-idaho-selenium-investigations/*.

Water column values for rivers throughout the state ranged from 0.1 µg/L to 1.8 µg/L (DEQ 2010) and were significantly lower than the statewide lotic water column value of 3.1 µg/L. The highest Se water column value was 1.75 µg/L at the Snake River near Homedale, Idaho, and subject to the proposed statewide criterion, followed by 1.57 µg/L at a site above Blackfoot Reservoir and close to phosphate mines. Nearly half the water samples analyzed had Se concentrations below the detection limit of 0.09 µg/L (DEQ 2010). These Idaho Se data show that in the vast majority of the state, aside from the limited area in which we already are addressing Se pollution, selenium concentrations are below both the statewide and SSC criterion elements.

This SSC is protective of resident fishes because we used the EPA-developed recalculation procedure for creating a site-specific toxicity dataset and species sensitivity distribution appropriate for deriving a site-specific aquatic life criterion (EPA 1985, 2013). Using this procedure, we found it appropriate to delete White Sturgeon from the national toxicity dataset and to recalculate the Se criterion elements based on the remaining resident species or species surrogates found in the national toxicity dataset as described in section 3. This approach reflects the nature of the pollutant and protects the beneficial uses and most sensitive resident species at the site as required in Idaho (IDAPA 58.01.02.275.01.h.ii.(5)(b)).

5.2 Downstream Waters

Aquatic life criteria must be met where they are applied, thus the statewide aquatic life Se criterion will need to be met in waters downstream of the Site. In the event a waterbody does not meet an aquatic life criterion, additional tools are employed to identify the source of the pollutant and address the issue (e.g., total maximum daily loads, source identification, point-source permit limits) so that aquatic life are protected within the waterbody and in downstream waters.

Protecting downstream waters is further required in IDAPA 58.01.02.070.08, which states that all waters must maintain a level of water quality at their pour point into downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including waters of another state or tribe.

5.3 Beneficial Uses

Under IDAPA 58.01.02, the waterbodies within the Site have the following designated or presumed beneficial uses:

- Cold water—water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species.

- Salmonid spawning—waters that provide or could provide a habitat for active self-propagating populations of salmonid fishes.
- Seasonal cold water—water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent during, or tolerant of, seasonally warm temperatures.
- Warm water—water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species.
- Modified—water quality appropriate for an aquatic life community that is limited due to one or more conditions set forth in 40 CFR 131.10(g), which preclude attainment of reference streams or conditions.

All beneficial uses of waters within the Site are protected by this SSC including salmonid spawning and cold water with no detrimental changes in biological communities of warm water or seasonal cold water since White Sturgeon is a phylogenetic outlier to all other fish species in Idaho and because of the geographical range of the Site. This complies with Idaho rules (IDAPA 58.01.02.275) and EPA guidelines (EPA 1985) for establishing site-specific criteria by not impairing designated or existing beneficial uses where aquatic communities do not vary substantially in sensitivity to pollutant within the specific geographical area described.

References

DEQ. 2010. *Arsenic, Mercury, and Selenium in Fish Tissue and Water from Idaho's Major Rivers: A Statewide Assessment*. Boise: Idaho Department of Environmental Quality.

DEQ. 2017. *Idaho's 2014 Integrated Report*. Prepared by Cara Hastings and Jason Williams. Boise, Idaho.

EPA. 1985. *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*. PB85–227049. US Environmental Protection Agency, Office of Research and Development.

EPA. 2013. *Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria*. EPA-823-R-13-001. US Environmental Protection Agency, Office of Water, Office of Science and Technology.

EPA. 2016. *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2016*. EPA 822-R-16-006. Washington, D.C.: Office of Water. Office of Science and Technology.

Formation and HabiTech, Inc. 2012. *Technical Support Document: Proposed Site-Specific Selenium Criterion, Sage and Crow Creeks, Idaho*. Prepared for J.R. Simplot Company.

FWS. 2015. *Biological Opinion for the Idaho Water Quality Standards for Numeric Water Quality Criteria for Toxic Pollutants.* OlEIFW00-2014-F-0233. Boise, Idaho: US Fish and Wildlife Service, Idaho Fish and Wildlife Office.

IDFG. 2005. *White Sturgeon (Snake River System), Acipenser Transmontanus*. Idaho Department of Fish and Game.

IDFG. 2008. *Management Plan for the Conservation of Snake River White Sturgeon in Idaho*. Boise: Idaho Department of Fish and Game.

IDFG. 2012. *Fisheries Management Plan 2013-2018: A Comprehensive Guide to Managing Idaho's Fisheries Resources.* Boise: Idaho Department of Fish and Game. https://idfg.idaho.gov/old-web/docs/fish/planFisheries.pdf.

Lo, B., J. Baker Marlatt, J. Elphick, M. Patterson Debruyn, B. Leighton, C. Kennedy, and H. Baily. 2014. *Effect of Dietary Selenium on Adult Slimy Sculpin (Cottus Cognatus) and Their Offspring.* presented at the Society of Environmental Toxicology and Chemistry, 35 th Annual North America Conference 2014, Vancouver, British Columbia, Canada.

NOAA NMFS. 2014. *Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation*. 2000–1484. Seattle, Washington: US National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Sigler, J. W., and D. W. Zaroban. in prep. "Fishes of Idaho – A Natural History Survey." Caldwell, Idaho: Caxton Press.

GIS Coverages

Restriction of liability: Neither the State of Idaho, nor DEQ, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. DEQ may update, modify, or revise the data used at any time, without notice.

Digital Orthoimagery Series of Idaho (2011, 1-m, Natural Color + IR).

NAIP - ortho_1-1_1n_s_id035_2009_1_1.sid.

Clearwater National Forest Landtypes, Landtype Associations, Landtype Association Groups Land System Inventory completed by Dale Wilson, Soils Scientist, Clearwater NF 1983–1993 Updates and Edits by Jim Mital, Soils Scientist, Clearwater NF 1993–present.

DEQ SDE Feature Classes: ADB Support 2010.

Pathfinder Sites: GPS waypoint transfer by MN DNR-Garmin applications.

Appendix A. Phylogeny of Idaho Fishes and Identification of Surrogates in the EPA Selenium National Toxicity Dataset

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Acipenseriformes*	*Acipenseridae*	*Acipenser*	*Acipenser transmontanus*	White Sturgeon	NO	YES	1
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Catostomus*	*Catostomus ardens*	Utah Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Catostomus*	*Catostomus catostomus*	Longnose Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Catostomus*	*Catostomus macrocheilus*	Largescale Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Chasmistes*	*Chasmistes muriei*	Snake River Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Pantosteus*	*Pantosteus bondi (Catostomus)*	Cascadian Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Pantosteus*	*Pantosteus columbianus (Catostomus)*	Bridgelip Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Pantosteus*	*Pantosteus platyrhynchus (Catostomus)*	Mountain Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Catostomidae*	*Pantosteus*	*Pantosteus virescens (Catostomus)*	Green Sucker	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cobitidae*	*Misgurnus*	*Misgurnus anguillicaudatus*	Oriental Weatherfish	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Acrocheilus*	*Acrocheilus alutaceus*	Chiselmouth	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Carassius*	*Carassius auratus*	Goldfish	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Couesius*	*Couesius plumbeus*	Lake Chub	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Ctenopharyngodon*	*Ctenopharyngodon idella*	Grass Carp	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Cyprinodon*	*Cyprinodon macularius*	desert pupfish	NO	YES	3,4
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Cyprinus*	*Cyprinus carpio*	Common Carp (including koi)	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Gila*	*Gila atraria*	Utah Chub	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Lepidomeda*	*Lepidomeda copei*	Northern Leatherside Chub	YES	NO	2

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Mylocheilus*	*Mylocheilus caurinus*	Peamouth	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Notemigonus*	*Notemigonus crysoleucas*	Golden Shiner	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Notropis*	*Notropis hudsonius*	Spottail Shiner	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Pimephales*	*Pimephales promelas*	Fathead Minnow	YES	YES	3
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Ptychocheilus*	*Ptychocheilus oregonensis*	Northern Pikeminnow	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Rhinichthys*	*Rhinichthys cataractae*	Longnose Dace	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Rhinichthys*	*Rhinichthys falcatus*	Leopard Dace	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Rhinichthys*	*Rhinichthys osculus*	Speckled Dace	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Rhinichthys*	*Rhinichthys umatilla*	Umatilla Dace	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Richardsonius*	*Richardsonius balteatus*	Redside Shiner	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Siphateles*	*Siphateles bicolor*	Tui Chub	YES	NO	2
Actinopterygii	*Cypriniformes*	*Cyprinidae*	*Tinca*	*Tinca tinca*	Tench	YES	NO	2
Actinopterygii	*Cyprinodontiformes*	*Fundulidae*	*Fundulus*	*Fundulus diaphanus*	Banded Killifish	YES	NO	2
Actinopterygii	*Cyprinodontiformes*	*Poeciliidae*	*Gambusia*	*Gambusia affinis*	Western Mosquitofish	YES	YES	3
Actinopterygii	*Cyprinodontiformes*	*Poeciliidae*	*Poecilia*	*Poecilia mexicana*	Shortfin Molly	YES	NO	2
Actinopterygii	*Cyprinodontiformes*	*Poeciliidae*	*Poecilia*	*Poecilia reticulata*	Guppy	YES	NO	2
Actinopterygii	*Cyprinodontiformes*	*Poeciliidae*	*Xiphophorus*	*Xiphophorus hellerii*	Green Swordtail	YES	NO	2
Actinopterygii	*Cyprinodontiformes*	*Poeciliidae*	*Xiphophorus*	*Xiphophorus spp.*	Platy	YES	NO	2
Actinopterygii	*Esociformes*	*Esocidae*	*Esox*	*Esox lucius*	Northern Pike	YES	YES	3,5
Actinopterygii	*Esociformes*	*Esocidae*	*Esox*	*Esox lucius X E. masquinongy*	Tiger Muskellunge	YES	NO	2

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Gadiformes*	*Gadidae*	*Lota*	*Lota lota*	Burbot	NO	NO	—
Actinopterygii	*Perciformes*	*Centrarchidae*	*Lepomis*	*Lepomis cyanellus*	Green Sunfish	YES	NO	2
Actinopterygii	*Perciformes*	*Centrarchidae*	*Lepomis*	*Lepomis gibbosus*	Pumpkinseed	YES	NO	2
Actinopterygii	*Perciformes*	*Centrarchidae*	*Lepomis*	*Lepomis gulosus*	Warmouth	YES	NO	2
Actinopterygii	*Perciformes*	*Centrarchidae*	*Lepomis*	*Lepomis macrochirus*	Buegill Sunfish	YES	YES	3,6
Actinopterygii	*Perciformes*	*Centrarchidae*	*Micropterus*	*Micropterus dolomieu*	Smallmouth Bass	YES	NO	2
Actinopterygii	*Perciformes*	*Centrarchidae*	*Micropterus*	*Micropterus salmoides*	Largemouth Bass	YES	YES	3,6
Actinopterygii	*Perciformes*	*Centrarchidae*	*Pomoxis*	*Pomoxis annularis*	White Crappie	YES	NO	2
Actinopterygii	*Perciformes*	*Centrarchidae*	*Pomoxis*	*Pomoxis nigromaculatus*	Black Crappie	YES	NO	2
Actinopterygii	*Perciformes*	*Cichlidae*	*Amatitlania*	*Amatitlania nigrofasciatum*	Convict Cichlid	YES	NO	2
Actinopterygii	*Perciformes*	*Cichlidae*	*Astronotus*	*Astronotus ocellatus*	Oscar	YES	NO	2
Actinopterygii	*Perciformes*	*Cichlidae*	*Oreochromis*	*Oreochromis aureus*	Blue Tilapia	YES	NO	2
Actinopterygii	*Perciformes*	*Cichlidae*	*Oreochromis*	*Oreochromis mossambicus*	Mozambique Tilapia	YES	NO	2
Actinopterygii	*Perciformes*	*Cichlidae*	*Tilapia*	*Tilapia zillii*	Redbelly Tilapia	YES	NO	2
Actinopterygii	*Perciformes*	*Percidae*	*Perca*	*Perca flavescens*	Yellow Perch	YES	NO	2
Actinopterygii	*Perciformes*	*Percidae*	*Sander*	*Sander canadensis*	Sauger	YES	NO	2
Actinopterygii	*Perciformes*	*Percidae*	*Sander*	*Sander vitreus*	Walleye	YES	NO	2
Actinopterygii	*Percopsiformes*	*Percopsidae*	*Percopsis*	*Percopsis transmontana*	Sand Roller	NO	NO	—
Actinopterygii	*Salmoniformes*	*Osmeridae*	*Osmerus*	*Osmerus mordax*	Rainbow Smelt	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Coregonus*	*Coregonus clupeaformis*	Lake Whitefish	YES	NO	2

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus aquabonita*	Golden Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus clarkii behnkei*	Snake River fine-spotted cutthroat trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus clarkii bouvieri*	Yellowstone cutthroat trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus clarkii henshawi*	Lahontan Cutthroat Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus clarkii lewisi*	Westslope Cutthroat Trout	YES	YES	3,7
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus clarkii utah*	Bonneville Cutthroat Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus kisutch*	Coho Salmon	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus mykiss*	Rainbow Trout (including redband and steelhead)	YES	YES	3,7
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus mykiss kamloops*	Kamloops trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus nerka*	Sockeye Salmon (including kokanee)	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Oncorhynchus*	*Oncorhynchus tshawytscha*	Chinook Salmon	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Prosopium*	*Prosopium abyssicola*	Bear Lake Whitefish	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Prosopium*	*Prosopium coulterii*	Pygmy Whitefish	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Prosopium*	*Prosopium gemmifer*	Bonneville Cisco	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Prosopium*	*Prosopium spilonotus*	Bonneville Whitefish	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Prosopium*	*Prosopium williamsoni*	Mountain Whitefish	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salmo*	*Salmo trutta*	Brown Trout	YES	YES	3,7
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus alpinus oquassa*	Sunapee trout - same as Arctic Char (Linder 1963)	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus confluentus*	Bull Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus confluentus X S. fontinalis*	bull trout x brook trout hybrid	YES	NO	2

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus fontinalis*	Brook Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus fontinalis X S. namaycush*	Splake	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Salvelinus*	*Salvelinus namaycush*	Lake Trout	YES	NO	2
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Savelinus*	*Salvelinus malma*	Dolly Varden	NO	YES	3,8
Actinopterygii	*Salmoniformes*	*Salmonidae*	*Thymallus*	*Thymallus arcticus*	Arctic Grayling	YES	NO	2
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus bairdii*	Mottled Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus beldingii*	Paiute Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus cognatus*	Slimy Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus confusus*	Shorthead Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus extensus*	Bear Lake Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus greenei*	Shoshone Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus hubbsi*	Columbia Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus leiopomus*	Wood River Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus rhotheus*	Torrent Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus schitsuumsh*	Cedar Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus semiscaber*	Bonneville Sculpin	YES	NO	9
Actinopterygii	*Scorpaeniformes*	*Cottidae*	*Cottus*	*Cottus tubulatus*	Snake River Sculpin	YES	NO	9
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Ameiurus*	*Ameiurus melas*	Black Bullhead	YES	NO	9
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Ameiurus*	*Ameiurus natalis*	Yellow Bullhead	YES	NO	9
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Ameiurus*	*Ameiurus nebulosus*	Brown Bullhead	YES	NO	9

Class	Order	Family	Genus	Genus/species/subspecies	Common Name	Site Resident?	Tested?	Note
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Ictalurus*	*Ictalurus punctatus*	Channel Catfish	YES	NO	9
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Noturus*	*Noturus gyrinus*	Tadpole Madtom	YES	NO	9
Actinopterygii	*Siluriformes*	*Ictaluridae*	*Pylodictus*	*Pylodictus olivaris*	Flathead Catfish	YES	NO	9
Cephala-spidomorphi	*Petromyzontiformes*	*Petromyzontidae*	*Entosphenus*	*Entosphenus tridentatus*	Pacific Lamprey	NO	NO	—

Notes: 1 - Deleted from dataset, 2 - Surrogate species is tested, 3 - Retained in dataset, 4 - Surrogate for Orders *Cypriniformes*, *Cyprinodontiformes*, 5 - Surrogate for Genus *Esox*, 6 - Surrogate for closely related species in Order *Perciformes*, 7 - Surrogate for closely related species in Order *Salmoniformes*, 8 - Surrogate for Genus *Salvelinus*, 9 - See Section Protectiveness of the SSC to Resident Fishes.

Appendix B. Available Selenium Concentrations in Water and Fish Tissue within Site (Subset from DEQ 2010).

Site	Site Name	Water (µg/L)	Date	Common Name	Scientific Name	Quantity	Muscle (mg/kg dw)	BAF (L/g)
17	Bear River	0.91	8/13/2008	Common Carp	*Cyprinus carpio*	10	2.44	2.68
5	Blackfoot	0.59	7/19/2008	Utah Sucker	*Catostomus ardens*	2	3.75	6.36
37	Blackfoot River #2	1.57	8/12/2008	Cutthroat Trout	*Oncorhynchus clarkii*	2	14.69	9.36
37	Blackfoot River #2	1.57	8/12/2008	Bridgelip Sucker	*Catostomus columbianus*	5	12.32	7.85
77	Henry's Fork	~0.14	7/17/2008	Cutthroat Trout	*Oncorhynchus clarki*	2	1.90	13.59
27	NF Big Lost	1.25	7/15/2008	Brook Trout	*Salvelinus fontinalis*	5	~6.74	5.39
85	Portneuf River	0.37	7/20/2008	Utah Sucker	*Catostomus ardens*	6	1.24	3.35
97	SF Snake	~0.29	9/24/2008	Rainbow Trout	*Oncorhynchus mykiss*	2	1.68	5.80
97	SF Snake	~0.29	7/18/2008	Cutthroat Trout	*Oncorhynchus clarkii*	2	2.15	7.42
97	SF Snake	~0.29	7/18/2008	Mountain Whitefish	*Prosopium williamsoni*	10	2.65	9.15
97	SF Snake	~0.29	9/24/2008	Brown Trout	*Salmo trutta*	10	1.81	6.26
97	SF Snake	~0.29	9/24/2008	Cutthroat X Rainbow Trout	*O. clarkii X O. mykiss*	1	2.52	8.69